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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

This Issue

OUTBOARD MOTORS— THEIR PRESENT AND FUTURE

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LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

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Outboard Motors—Their Present and Future

THE much-discussed horsepower race of the American automobile manufacturers has had a relatively unpublicized little brother in the outboard motor field. Outboard motor history in the last few years includes three facets very similar to automotive history. One is the tremendous growth in the actual number of outboard motors in use, another is the increase in popularity of higher horsepower motors, and the third is the widespread acceptance of new accessories by the outboard enthusiasts.

While lower horsepower outboards are still sold in large quantities, their percentage of total sales is diminishing. Higher horsepower motors (12 HP to 70 HP), accounted for half of the total number of outboards sold in 1957. There are, of course, many reasons for the popularity of the larger size motors. Among them is simply a desire for more speed on the part of the boat owner. Certainly the sport of water skiing has had its share in creating a demand for more speed—and larger power plants to give that speed.

One of the most important contributions to the development of the high-horsepower outboard engine has been the gearshift which permits forward, neutral and reverse operation.

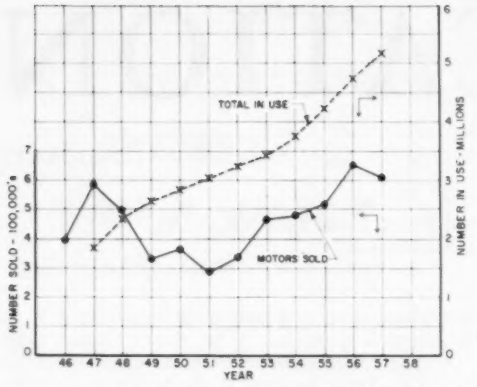
The wider use of outboard motors to drive cabin cruisers has also increased the demand for higher horsepower. It is not unusual today to see two outboards of fairly large size side-by-side on the transom of a cruiser, performing the job normally assigned to an inboard engine.

First let us look at the recent history of outboard motor growth from the standpoints of the number of motors sold and in use. Figure 1 shows these numbers for the years 1946 through 1957. While the number of outboard motors sold dropped sharply in 1949 and did not increase until 1953, later years have shown a steady increase. On the other hand, the total number of outboards in use has increased steadily over these years. The increase has been more rapid since 1954.

To further illustrate the marked growth of outboard motors, the total rated horsepower available in outboards on January 1, 1957 was 40,500,000. In the autumn of 1957 this figure was estimated at 49,500,000 horsepower.[1] This represents an increase of 23.5% in less than one year.

Figure 2 illustrates the trend in outboard motor size in recent years. The upper curve (0-7 HP) indicates that demand for the very smallest motors is decreasing rapidly. The middle curve (7.1 to 12.0 HP) indicates that engines of this "conservative" size are holding their own. But the lowest curve (12.1 HP and up) shows a steadily increasing demand for the larger engines which has exceeded the other two groups since 1955 and is now greater than both combined. If the range of 12 horsepower

[1] From data compiled by the Outboard Boating Club of America.



Courtesy of Outboard Boating Club of America

Figure 1 — Sale and use of outboard motors, 1946 through 1957.

and up were further broken into smaller increments, the increasing demand that now exists for motors of 35 horsepower and up would be startling. Figure 3 shows a typical "luxury" outboard motor rated at 40 HP, which includes such features as key electric starting, electric fuel pump, power bailing, 12-volt electrical system with built-in generator, full underwater exhaust, ultra quiet operation and built-in remote control connections. Figure 4 illustrates a 35 HP outboard and the trend towards automotive-type centralized controls including in this instance a "dash" light.

The general increase in horsepower ratings has been accomplished mainly by increasing engine displacement. This increase in displacement has been made in two ways (1) by increasing the bore and stroke, and (2) by increasing the number of cylinders. Where one and two cylinder engines were commonplace a few years ago, engines of three, four and six cylinders are becoming popular today with outputs as high as 70 horsepower.

One exception to the above is the increase in horsepower made by raising engine speed. Four thousand revolutions per minute, more or less, has been almost standard for at least the last decade, but some models are now available with a rated speed of 5800 rpm. By increasing the speed, it is possible to keep engine size reasonable, and still increase horsepower output.

Outboard engines operating on the two-stroke cycle principle are in the vast majority today and a two-stroke cycle opposed piston *diesel* engine has recently been announced. A few four-stroke cycle gasoline engine outboards are available. In the two-stroke cycle operation, one revolution of the crankshaft is required for the complete power cycle. Two revolutions of the crankshaft are required to complete the four-stroke cycle power process. The movements of the piston give these cycles their names, two movements being required to complete the two-stroke cycle, and four movements to complete the four-stroke cycle. Figure 5 illustrates and describes the operation of one common type of two-stroke cycle engine.

This points up some of the advantages that the two-stroke cycle offers for outboard motor operation. Among these are better horsepower to weight ratio, since twice as many power strokes per revolution are made with the two-cycle engines. Secondly, the two-stroke cycle eliminates the need for complex valve trains, and lubricating oil systems. The four-cycle outboards offer the advantages that premixing of fuel and oil is not required, and slightly quieter operation is claimed.

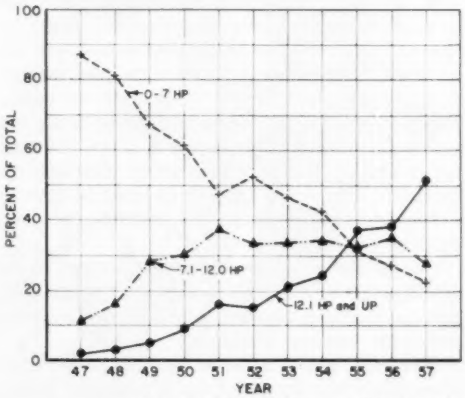
NEW DEVELOPMENTS

In the growth of the outboard from the fisherman's friend to family use, the original relatively simple machine has become a complicated and highly refined mechanism. This complexity is illustrated by the cut-away of the 3 cylinder 40 HP outboard engine in Figure 6 and the 4 cylinder vee type engine of Figure 7. The number and type of accessories, or "extras" compared to yesterday's stripped-down model are making the outboard into a closer relative to automotive engines with every passing year.

Many of the following features are obtainable on most models and on most makes of outboards. In only a few instances are accessories "exclusive" to one make or model of outboard. Thus, the consumer has a very wide range of outboard motors to choose from, being limited only by personal choice and by what he wishes to pay.

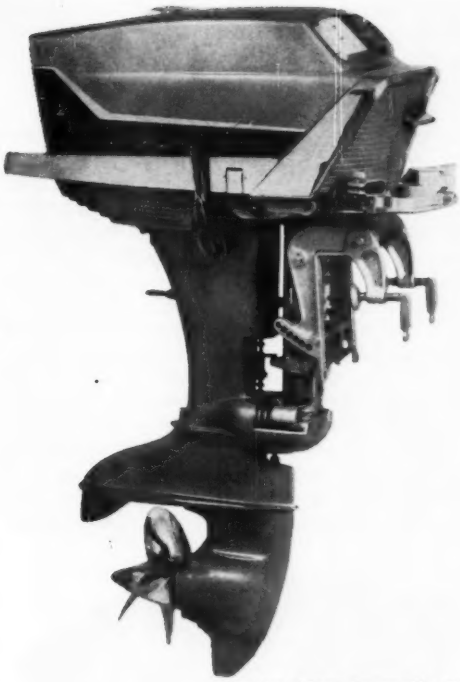
Some of the areas in which outboards and automotive engines are similar are:

Multiple carburetion



Courtesy of Outboard Boating Club of America

Figure 2 — Trends in outboard motor horsepower.



Courtesy of Scott-Atwater Mfg. Co.

Figure 3 — A 40 HP "luxury" outboard motor with numerous built-in features.

Thermostatically controlled cooling systems
Electric starting
Electric generation for accessories and ignition
Mounting for vibration and noise isolation.

Refinements such as these should discourage an inept tinkerer from attempting to strip such an engine and to re-assemble it with an old pair of pliers, monkey wrench, and battered screwdriver. In fact, most manufacturers suggest a hands-off policy except for very minor repairs and cleaning. A closer look at some of the recent design improvements makes this very easily understood.

Multiple Carburetion

The carburetor illustrated in Figure 8 is a twin-barrel down-draft type. Both barrels are mounted on a common body, with each barrel feeding two cylinders. Secondary venturis thoroughly atomize the fuel, and separate high and low speed jets for each bank of two cylinders (V engine) are synchronized by the central control knob. Motor speed is controlled by butterfly type valves in each barrel, and magneto timing is actuated by the throttle control.

Butterfly type choke valves (just visible in Figure 8) are located just above the venturis, and are remotely controlled by the electric solenoid mounted on the left side of the carburetor. A choke knob is also provided for manual "at motor" operation.

Thermostatically-Controlled Cooling System

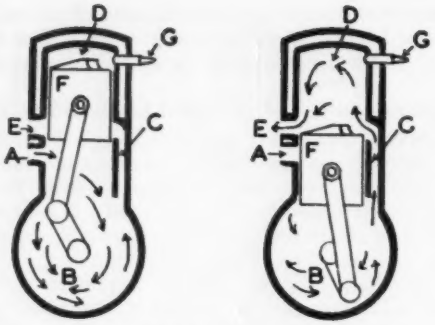
Another automotive type innovation is the thermostatically controlled cooling system, a simplified outline being illustrated in Figure 9. With this system, the cooling water is first caused to recirculate through the cooling system. The water reaches the set normal operating temperature of 150°F very quickly, at which time the thermostat opens and discharges part of the hot water, which is replaced with cold water. This recirculating, discharging, and replacing of water is a continuous process which maintains a uniform operating temperature. Advantages claimed for this system are faster warm-up, better performance, more economical operation, and reduced engine wear.

Electric Starting

The electric starter system diagrammed in Figure 10 is a 12-volt type especially designed for outboard use. It consists of a 12-volt electric starter, an electrically operated choke, an alternating current (AC) generator, a full-wave rectifier (which converts the generated AC current to DC current for battery charging and ignition) and an automotive type

Courtesy of West Bend Aluminum Co.

Figure 4 — A 35 HP outboard illustrating automotive-type centralization of controls.



Upward (compression) stroke compresses mixture in cylinder "D" in preparation for ignition. Simultaneously, it creates a partial vacuum in the crankcase so that, as intake port "A" is uncovered fuel-oil-air mixture for a new charge flows in from the carburetor. At the end of the upward (compression) stroke, spark plug "G" ignites the compressed mixture.

The resulting combustion pressure forces the piston downward (power stroke) furnishing power to turn the propeller. As piston descends it closes intake port "A" and compresses mixture charge in the crankcase. Towards the end of the stroke exhaust port "E" is opened; then bypass port "C" is opened which permits new mixture to flow into cylinder "D", displacing the burned gases through exhaust port "E".

Figure 5 — Operation of a two stroke cycle engine.

ignition system with distributor and two coils. The system consists of four circuits: (1) generating, (2) starting, (3) choke, and (4) ignition.

All control, except for actually turning the ignition key "on" or "off", is done with a single control lever and start button. Under this system, the operator has one-hand control of starting, speed, forward direction and reverse (by stopping and restarting the engine in opposite rotation). As will be seen later (under transmissions) this is an unusual control method which is employed by one manufacturer and useable with electric starting.

Electric Generator

To provide the power for accessories such as running lights, spot light, horn, or even a radio, several manufacturers offer an electric generator. Use of a generator system yields an efficient, durable means of providing a boat's electric power requirement, and of keeping the battery at full-charge for starting the motor. Figure 11 illustrates a generator of the direct-current type.

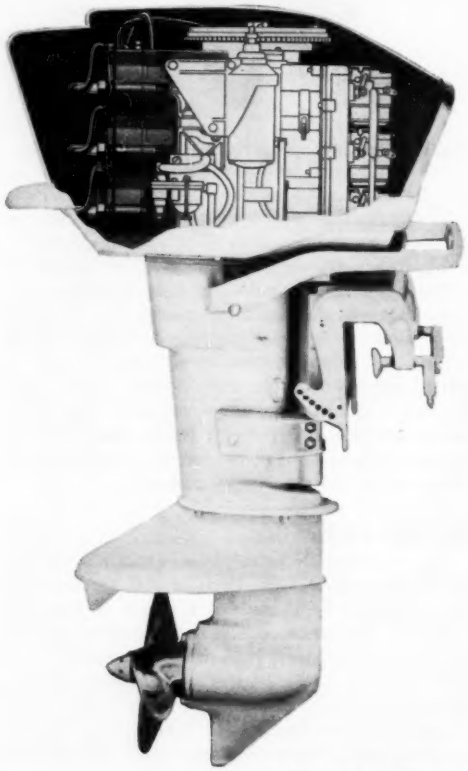
Noise Suppression

With the increased popularity of outboarding, noise is increasingly unwelcome, especially on confined inland waters. This has been recognized by outboard manufacturers, who have exerted great efforts to allay this problem. The nearly universal trend to underwater exhaust has contributed in large measure to noise reduction. Another solution is shown in Figure 12, a "phantom" view of a late model outboard. The arrows indicate the location of rubber seals and cushions which it is claimed nearly completely isolate sound and reduce transmission of noise and vibration to the hull which frequently amplifies these undesirables.

Transmissions

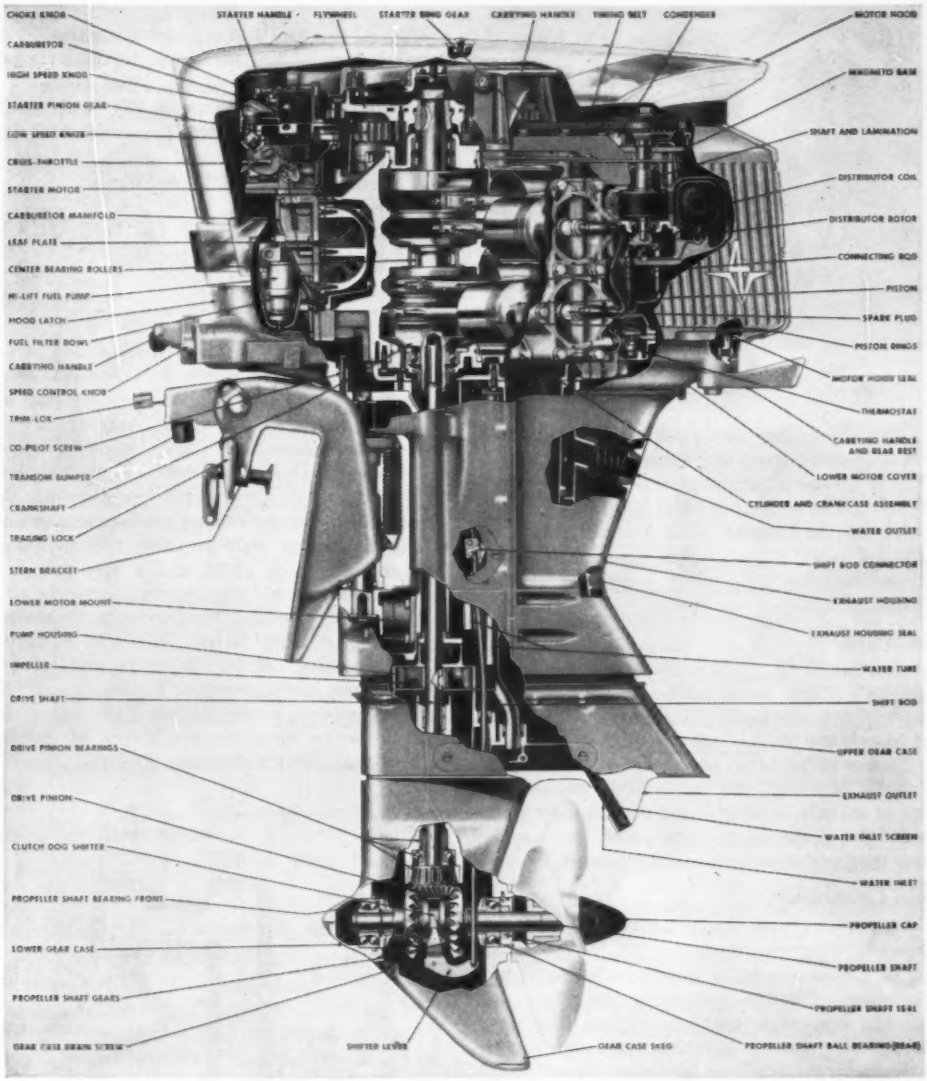
The lower portion of Figure 7 also illustrates the most widely used type of lower unit or transmission consisting of the central engine-driven pinion gear which is in constant mesh with the two propeller-shaft gears. The latter rotate freely on the propeller shaft at the same speed but in opposite directions. A slideable manually-operated clutch between the two propeller-shaft gears is splined to the propeller shaft and can be shifted either forward or backward to clutch into one of the propeller gears. In its central position, the clutch dog avoids both gears and thereby provides a neutral position which permits the engine to be run without turning the propeller.

Figure 13 presents an automatic transmission consisting of a miniaturized bevel gear differential very similar to that used in automotive rear ends. The upper driving gear is driven by the engine,



Courtesy of Scott-Atwater Mfg. Co.

Figure 6 — Cross-section of a modern three-cylinder 40 HP outboard engine.



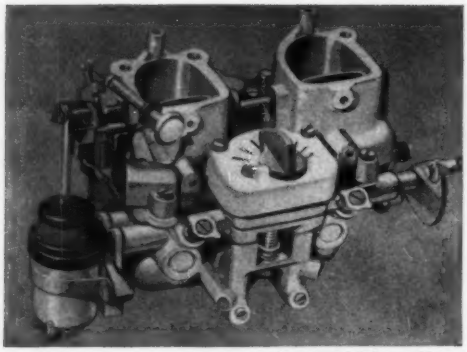
Courtesy of Evinrude Motors

Figure 7 — Cross-section of a modern 50 HP V-4 outboard engine.

while the lower driven gear is connected to the propeller. Two horizontal pinion gears, supported in a cylindrical carrier, mesh with both the upper and lower gears, forming a planetary assembly. The entire assembly fits closely, but with clearance, in a circular bore of the drive shaft housing.

Shift control is accomplished by two "wrap-up" spring clutches, a small one between the drive shaft and the driving gear and a large one between the driving gear and the pinion gear carrier. The driving gear therefore has two clutching surfaces, a small diameter just above the gear and an integral drum with an outside diameter to match the outside diameter of the idler gear carrier.

In forward speed, the drive gear is locked both to the drive shaft (by the small spring clutch) and to the pinion gear carrier (by the large spring clutch). The pinion gears can not rotate and merely serve to lock the upper driving gear to the lower driven gear. Thus the entire assembly rotates as a



Courtesy of Johnson Motors

Figure 8 — Twin-barrel downdraft carburetor.

unit and the engine thereby drives the propeller shaft at the same speed and direction.

Figure 13 also illustrates several other interesting design features such as a swept-back leading edge (which lets the outboard slide over submerged or floating objects), a large rubber-mounted propeller, and the discharge of cooling water and exhaust through the hollow propeller hub.

Power Bailer

A boon to outboarders is power bailing. Figure 14 shows a system developed to eliminate the laborious dipping, sponging, dumping, or pumping that has always plagued small boat owners. Arrow "A" points to the bailer hose between bailer intake screen "B" and the bailer pump in the engine. The latter is entirely separate from the engine's water pump "D", consequently bilge water does not circulate through the engine cooling passages.

Twin Outboards

The previously-mentioned use of twin outboard engines is illustrated in Figure 15. With control systems now available, it is possible in such dual installations to utilize completely the power and flexibility inherent in both the engines. The large amounts of power that can be obtained in this manner, with practically no boat space wasted makes this a very attractive arrangement for small and medium sized cabin cruisers.

Inboard-Outboard Engine

In Figure 16, an outboard engine converted for inboard use is illustrated. This engine is of four-cycle design, but installations of this type are not limited to this form of engine. Installations such as this still retain the flexibility built into outboards, since the whole engine is easily removable for repair or storage.

Diesel Outboard

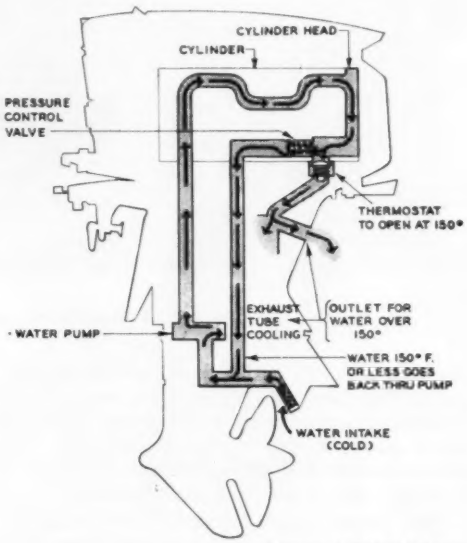
Figure 17 illustrates the 7.5 horsepower model of a diesel powered outboard motor which was introduced this year and represents something new on the American outboarding scene. It is claimed that ease of operation of the diesel outboard is on a par with gasoline outboards, with added safety because of the high-flash fuel used. This engine of opposed piston design is available in both air-cooled and water-cooled models.

CARE AND USE OF OUTBOARD ENGINES

Gasolines

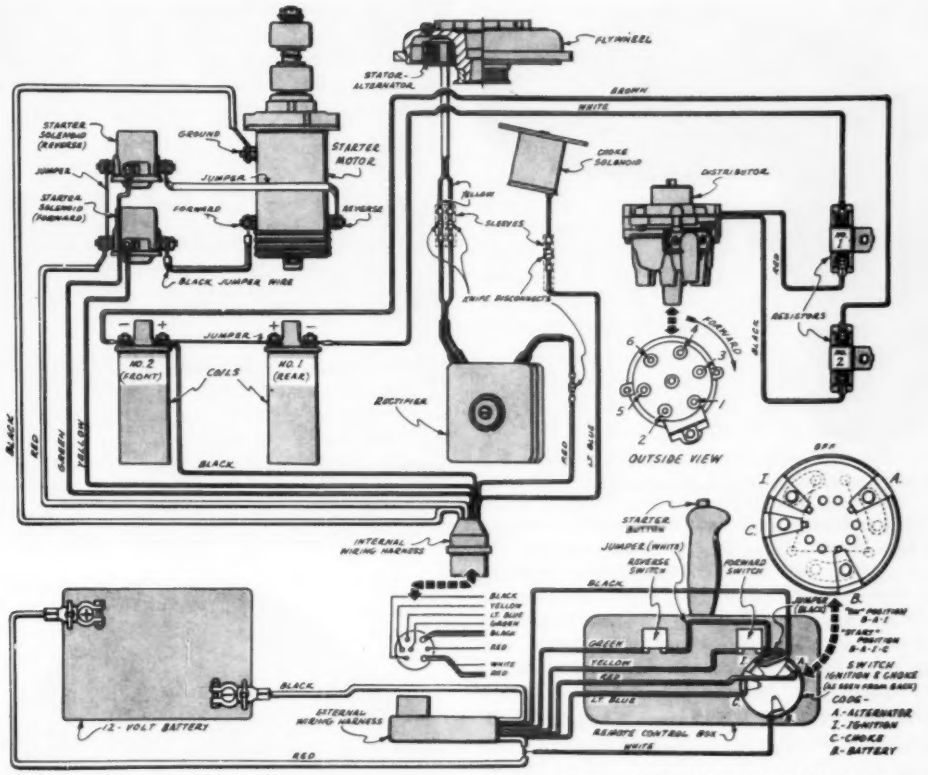
Early History

Originally, gasoline was only a dangerous unwanted by-product which was distilled off as a contaminant during manufacture of the all-important kerosine and then either thrown or given away. Fortunately (for that time) only 5 or 10% of gasoline was obtained from the crudes of that day and the disposal problem was not too difficult. The early horseless buggies, inboard marine engines as early as 1886, Ole Evinrude's outboard engine of 1906, and a very few farm and stationary power plant engines were the original users of gasoline. They became enormously successful primarily because they could convert this inexpensive but potent waste product into useful power and convenient transportation. The airplane couldn't break the bond of gravity and stay in the air until the availability of gasoline enabled the Wright brothers to build the first



Courtesy of Evinrude Motors

Figure 9 — Schematic diagram of thermostatically controlled cooling system.



Courtesy of Mercury Outboard Motors, Kickhaefer Corporation

Figure 10 — One-hand electric starting and control system.

engine in 1903 that combined adequate power with light weight.

Straight-Run Gasoline

Compression ratios in those days were no more than two or three to one and hardly worthy of the title. However, all gasolines were of the straight-run type, and largely from paraffinic crudes obtained in Pennsylvania, the Midwest and East Texas, consequently their antiknock values were both low and variable. A certain midcontinent straight run probably holds the record low of 20 octane. As a consequence, the large-bored slow-speed automobile engines of those days would hammer mightily on a hill; since the noise could be reduced or eliminated by retarding the spark hand-lever, it was usually called "spark knock," though "carbon knock" was also applied. Several years were to pass before spark and carbon knock were properly identified as "detonation" and it was realized that gasoline quality had something to do with it. But regardless of their faults these early white-colored gasolines had one virtue which is remembered too well to this day: most of them were naturally "stable," that is they could be stored for long periods, even when sloshing around in old-fashioned copper boat tanks, without developing appreciable quantities of gasoline gum. These gasolines then were responsible for the persistent but untrue fable that a colorless "white gasoline" was automatically best for outboard engines.

Thermal-Cracked Gasoline

Once started, the demand for gasoline grew so rapidly that it became the primary product and the 5 to 10% production from the crudes then available was no longer adequate. Furthermore, the electric light began to rapidly replace the oil lamp, kerosine became the secondary product, and proper use of it and the remainder of the crude barrel now became the refiners' problem. Fortunately for everyone in 1912 William Burton patented the discovery that when crude oil was heated under pressure, a portion of the heavy more-viscous parts of the crude was broken down or "cracked" into an entirely new "thermal-cracked" gasoline.

Courtesy of Johnson Motors

Figure 11 — Electric generator with non-slip belt.

With the Burton and the more highly developed Holmes-Manley processes, as much as half the crude barrel could now be changed into gasoline, thus the future of the gasoline engine was assured. Thermal-cracked gasoline was a man-made product and markedly different from nature's straight run. For example, the user immediately noticed its remarkable ability to eliminate spark knock, thus permitting engines to be built with higher compression ratios to produce far more power and better economy with no increase in size or weight. But the *early* thermal-cracked gasolines had one defect: unless stored with suitable protection from sunlight, air, high temperatures, agitation and metallic copper, and unless used within a few weeks of manufacture, the original thermal-cracked gasolines would gradually turn yellow and form yellow sticky sweet-smelling non-volatile gum which either deposited wherever the gasoline evaporated, or reached such high concentration as to precipitate in gasoline tanks. Several effective methods of preventing gum formation in thermal-cracked gasoline, notably the use of tiny amounts of any of several anti-oxidants, were found subsequently but the public's memory of thermal-cracked's youthful indiscretion lingers.

But notice particularly that the greatly-different straight-run and thermal cracked gasolines were both white-colored, which should be ample evidence that a white color in itself is certainly no reliable indication of stability and no guarantee against gum formation. In fact, then and now, a customer had no means of distinguishing between good and bad white gasolines until it was too late and the damage was done. Then and now the customer's best protection is the reputation of the refiner supplying the product.

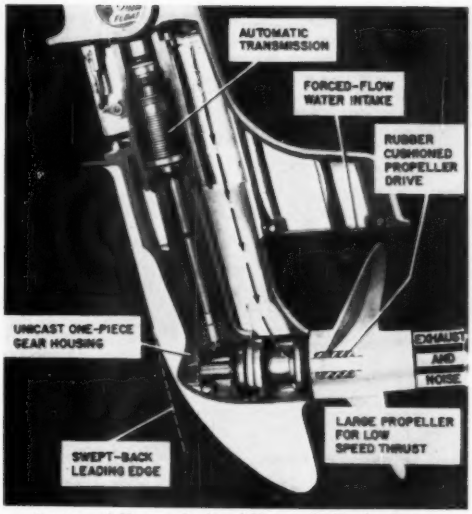
Thermal-cracking reached its zenith in the thirties and has been largely replaced with such modern, efficient and more effective processes as *catalytic* cracking and reforming which produce a more stable and higher octane product.

Tetraethyllead

Reverting a little, it was discovered in 1922 that a very small amount of a colorless, odorless and tasteless chemical called tetraethyllead would vastly increase the antiknock quality of a gasoline. In fact, tetraethyllead was so effective that if an open bottle of it was merely placed near the carburetor of a knocking engine, the infinitesimal sniff of tetraethyllead vapor in the air would immediately quiet the engine. Thus increased antiknock quality of a gasoline is obtainable by either (but usually both) complex refining processes and tetraethyllead: the balance between the two is carefully worked out to give the best gasoline for the least cost. The *maximum* amount of lead used today is only three volumes in 3785 of motor gasoline, or considerably less than one tenth of one percent.

Courtesy of Evinrude Motors

Figure 12 — Use of sound and vibration insulators.



Courtesy of Mercury Outboard Motors, Kickhaefer Corporation

Figure 13 – Automatic transmission.

Like many other chemicals in common use, tetraethyllead is poisonous, consequently as a public service it was agreed that any gasoline containing any amount of it would be colored in some manner, usually with a harmless red dye, to discourage use other than in engines.

Some motor gasolines of that early day contained substantial amounts of *uninhibited* thermal-cracked gasoline together with the red-dyed tetraethyllead, and thereby generated another long-lived fallacy. When such a gasoline formed gum and then evaporated, the non-volatile gum and red dye remained as a red deposit. Observing these deposits on the outside of carburetors, a few people immediately jumped to the false conclusions that either the tetraethyllead or the red dye had formed gum and that red-colored gasolines were therefore unsuitable. Of course it's inexplicably illogical that such a person could reject a red dyed gasoline for his occasional outboarding, yet use it every day in his automobiles. In any case the technical truth is that *neither tetraethyllead nor its red dye have any effect whatsoever on gasoline gum formation: they can neither encourage nor prevent it.* Gasoline gum can be formed only from the base gasoline itself, and again the refiner's reputation and recommendation is the customer's best guarantee of quality.

"Marine White" Versus Modern Gasolines

In the past and because of the phobias and superstitions described in the foregoing, a very few major refiners have manufactured special "marine white" gasolines for use in outboard engines, conservative inboard engines, lawn mowers, gasoline lanterns and gasoline stoves. These gasolines were usually of the straight-run type with conventional refinement and preferably from selected crudes that gave a fair measure of natural stability and moderate antiknock. Since neither tetraethyllead nor its requisite dye nor in fact any other additives were used, these gasolines were uncolored or *"white"* (though the less stable ones would turn yellow and begin gum formation in a few weeks). The inherent natural stability of the better "white" gasolines helped them to resist the adverse effects of careless or forgetful storage in copper boat tanks, hence they acquired the additional adjective of *"marine."*

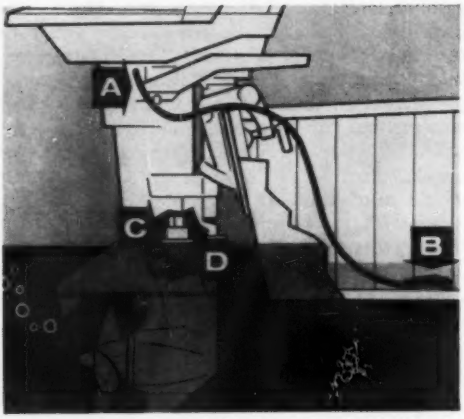
Since their antiknock value was wholly dependent on crude source and refining methods, the octane values of these marine white gasolines ranged from a low of 60 to as much as 80 for the best. Only the best refiners seemed to maintain any close control of this quality. Though outboard engine manufacturers seem to exhibit little concern about gasoline antiknock value, most of them actually regard 90 octane "regular grade" leaded motor gasoline as their standard fuel and utilize it for their own test work. And quite different from the previous viewpoint they now look upon even 80 octane marine white gasoline as an acceptable but somewhat special and largely unobtainable fuel.

On the other hand *inboard* engine manufacturers continue to obtain increased power and economy without increase in engine size or weight by upping compression ratios and consequently octane appetites. Even 80 octane marine white gasoline would still be grossly inadequate in the most modern inboard engines and would cause destructive detonation. Successful use of such a low octane fuel would therefore require either severe restriction to part-throttle operation or retarding of engine ignition timing, both methods resulting in loss of power, reduced speed and lower economy. In summary, though the smaller *outboards* can successfully use marine white gasoline, many of the *inboards* require far higher octane: where both outboard and inboard engines utilize the same gasoline, or where confusion between two gasolines may occur, it is safer and far more satisfactory to use the single high octane gasoline for all engines.

At least one modern high octane marine gasoline offers several other advantages to the outboarder:

a. Maximum availability – already much better than marine white and growing rather than shrinking.

b. Maximum ease of starting and freedom from vapor lock since volatility is adjusted every month to best suit the existing atmospheric



Courtesy of Scott-Atwater Mfg. Co.

Figure 14 — Automatic Power Boiler.

temperature and altitude wherever it is purchased.

c. Maximum "refinery freshness" because gasoline volatility is changed as often as every month, and increasing usage requires frequent replenishment of sales tanks.
d. Maximum protection against gum because of stable base stocks additionally fortified with effective additives, and by frequent replenishment.
e. Maximum power and economy potential.
f. Maximum engine life because of protection against wear and rusting.

Engine Oil

In most two-cycle outboard engines, the engine oil is premixed with the gasoline, then fed through tank, carburetor, and crankcase into the engine's cylinders. Thus, the engine's crankcase is essentially dry while crankshaft and connecting rod bearings, cylinder walls and pistons are lubricated with the oil that remains after the gasoline in the oil-gasoline fog from the carburetor has evaporated. The chief advantages of this unique lubrication system are its stark simplicity and light weight. For best operation in outboards more than any other engine, the gasoline and oil must form a closely knit team, perfectly suited to each other and to the engine. *Selection of the correct amount, type, viscosity grade and proper mixing of the lubricating oil is the most important single contribution that the operator can make to preserve the reliability, power, economy and life of his outboard engine.*

Amount of Oil

Each engine manufacturer prescribes the nominal amount of oil for each engine model, the specific figure being found in the owner's manual or other engine manufacturers' publications, but most easily in guides, cruising manuals, marine lubrication charts and similar publications by major refiners who have extensive marine interests.

Manufacturers' recommendations vary between ⅓ to 1½ pints of oil per gallon of gasoline (or gasoline to oil ratios between 24 and 5 to one), the most common being ½ pint per gallon. During break-in of new engines, most manufacturers recommend 50% more oil in the mixture than for normal usage, the most common break-in mixture being ¾ pint of oil per gallon of gasoline.

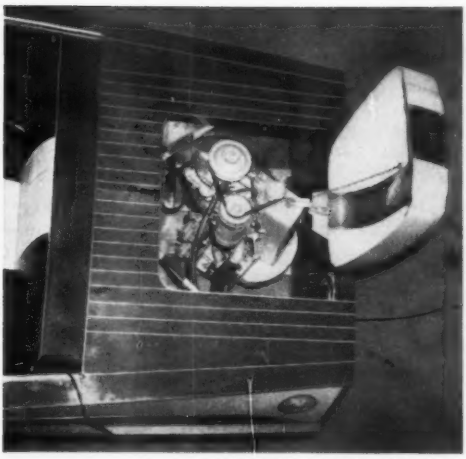
Unlike automobile engines (which recirculate and continually re-use their oil), the two-cycle outboard uses its oil just once. Thus, the oil in an outboard engine is expected to meet two difficult *and exactly opposite* requirements:

1. During the fleeting fractional seconds of its residence in the combustion chamber, it is expected to *resist burning* while lubricating piston and cylinder wall and preventing ruinous seizure.
2. After completing its lubrication job, it is expected to *burn*, and to burn completely without leaving carbonaceous or varnish residues. Furthermore, it should burn away or leave the combustion chamber at the same rate that new oil enters, otherwise oil must accumulate to produce carbon and to foul the spark plug.

The attainment of such a perfect balance between the opposites of burning and not burning would be difficult enough if the outboard engine were always operated at the same load and speed, but such is far from the case. The outboard engine uses at least 250 times more oil than an automobile engine, and it uses exactly the same proportion regardless of whether it is idling or operating at top speed. Under prolonged idling or trolling condi-

Courtesy of Evinrude Motors

Figure 15 — Twin Outboard Installation.



Courtesy of Fageol Marine Engine Co.

Figure 16 — An inboard-outboard motor.

tions, very little oil is actually needed; furthermore, combustion chamber temperatures are so low that the oil is ignited with difficulty and burns incompletely, as evidenced by the normal trail of blue oil smoke above the wake. Under the opposite condition of full load and high speed, however, temperatures are high, excess oil is readily consumed and the engine should be given abundant quantity as insurance against running hot, possible seizure and total destruction. Between the opposite requirements of light and heavy load, the manufacturer naturally protects against the latter by prescribing the use of ample oil: as a consequence, under light loads, some exhaust smoke, possible carbon buildup and the minor annoyance of occasional spark plug fouling may occur in some engines.

Oil Type and Viscosity

Use of the proper *type* and *viscosity* of lubricating oil will greatly enhance pleasurable outboard operation. By type is meant those basic qualities of the original crude as modified by refining which affect the oil's lubricating and subsequent burning qualities. Viscosity, of course, refers to the fluidity or "body" of the oil, which also affects lubricating and burning qualities, and is usually described in terms of Society of Automotive Engineers viscosity grades, such as SAE 30 or SAE 40. Straight mineral non-additive lubricating oil is the historic and still largely used type. One refiner meets the widely-differing requirements of engines and operating conditions by providing two grades of outboard motor oil: (1) an SAE 30 grade, of special base specifically designed for light and medium duty with occasional bursts of speed in moderately-powered engines and (2) an SAE 40 grade of another base designed for continuous duty in the highest powered and racing engines.

Additive oils have been discouraged for outboard use, largely because of the looseness of popular definition of "additive," and because certain metallic bases of certain detergent-dispersant additives in certain engines tended to enter into unholy alliances with lead salts and form electrically-conducting "whiskers" which bridged or short-circuited the spark plug gap and caused misfiring. The reader should recognize the many "certains" in this statement and rightly conclude that the condition is specific, not general. In short, additives should never be condemned merely because they are additives.

The American market is currently flooded with a wide variety of proprietary mixtures euphemistically advertised as "additives" but more commonly called "snake oils": these materials are recom-

Courtesy of American Marc Corporation

Figure 17 — Diesel outboard engine.

mended by no one but their own sales promotion departments.

Gasoline-Oil Premixture

The proper proportion, accurate measurements and thorough premixture of oil and gasoline for outboard use are vital. Once properly mixed the oil cannot "separate" or "settle out": any claim of contrary experience is first-rate evidence of careless, incomplete mixing.

Never attempt to mix fuel in the engine tank, but use a clean can (or the running tank) that can be tightly closed, preferably with a screw cap and gasket. Allow some space in the can to facilitate shaking and thorough mixing; for example if a five gallon can is chosen make measurements to mix only about a four gallon batch. First put two or three oil volumes of gasoline into the can followed by the oil and shake thoroughly. Add the remainder of the gasoline and shake the whole. The heavier the SAE grade of oil the more shaking is required to dissolve it.

Since gasoline evaporates even if oil doesn't, the original gasoline-oil mixture will get richer in oil unless suitably protected. Fuel cans should be kept tightly sealed and out of the sun, and should not be mixed too long in advance of use. Old fuel and open fuel containers contribute to hard starting and fire hazard. Fill the engine and auxiliary tanks through a funnel having a very fine (100 to 200 mesh) brass or monel screen or the old chamois to remove possible dirt and water, or other contamination that may occur during mixing.

Gear Lubricant

Since the lower gear case is completely submerged when in use, the entry of water must be discouraged either or both by effective seals or by keeping the case nearly full of lubricant. Depending largely upon the sealing arrangement, the engine manufacturer may recommend either outboard motor oil, an extreme pressure gear oil, or a special gear grease. Regardless of form and in addition to proper gear and bearing lubrication, the gear lubricant should provide good rust protection.

Engine Storage

The proper preparation of an outboard for storage during periods of inactivity is very important. The small amount of time and effort required will immeasurably add to the life of the engine and the pleasure of using it.

If the engine has been used in salt water, its cooling system should at least be flushed out with fresh water but preferably should actually be operated for a few minutes in fresh water. The engine cylinder and crankcase parts can be effectively rust-proofed at the same time by operating ("running out") the engine on a quart or less of a normal mixture of gasoline with an abnormal outboard engine oil – a highly detergent oil! In addition to their detergency (which is unimportant in itself for this purpose) the best of the highly detergent oils also possess the best rust-prevention ability of any oils generally available to the public.

The next step is to completely drain the engine and auxiliary tanks, fuel lines and carburetor of all remaining fuel. If the gasoline was of the modern high-octane type, by all means use up any remaining outboard fuel in an automobile.

Next, drain the lower gear case of water and lubricant and force out any remaining water by refilling with new lubricant. Gear lubricants in collapsible tubes are available which greatly facilitate this maintenance item. Finally, wipe off exposed metal parts with a rag and a few drops of that detergent motor oil, and store the engine in its normal vertical position.

RULES OF THE ROAD

Know the rules, and obey them all, including the Golden Rule.

Keep to the right. Rowboats, canoes and sailboats (except when overtaking you) always have the right of way. Any boat approaching from the right has the right of way.

If operating in navigable water, check Federal regulations as to equipment required.

Some states prohibit trolling or fishing from a motor equipped boat.

Do not speed close to bathers, fishermen or other boats.

Cruise quietly, with cutout closed, especially in early morning hours.

Help popularize outboard motoring. Do not spoil a grand sport.

SUMMARY

The number of outboard engines in use has almost tripled during the last ten years. Engine horsepower ratings have also steadily increased with a total of almost 50,000,000 rated horsepower now in operation. In addition to superlative performance and reliability, engine design is characterized by such contributions to ease and pleasure of operation as push button electric starting, remote controls, automatic transmissions, electric generators, and power bailers. The leaders in the petroleum industry continue to keep pace with these developments by manufacturing and providing wide availability to the best in fuels and lubricants.

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MADE TO ORDER FOR OUTBOARDS

This perfect oil-fuel combination cuts down deposits...steps up power!

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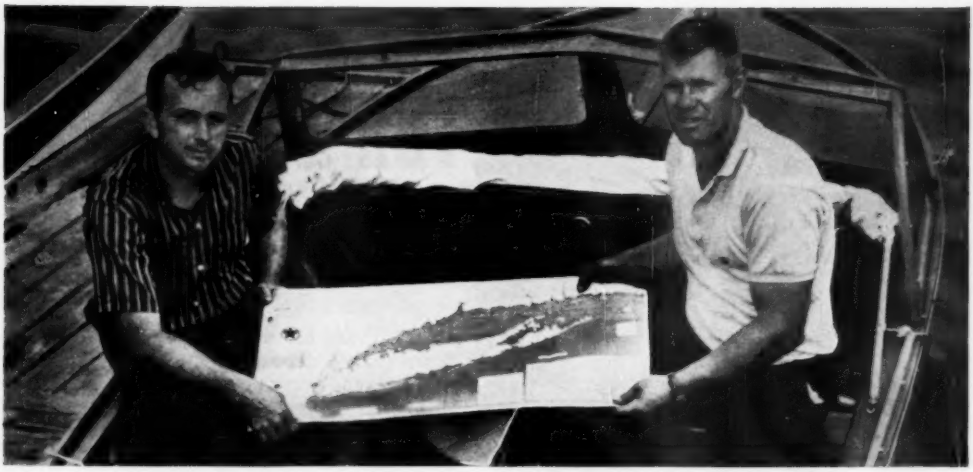

RECORD MAKERS: Texaco Dealers Al Grover (left) and George Burmester of Freeport, L. I., N. Y., made only one stop in the 280-mile run—to refill with Texaco Sky Chief Marine gasoline.

REMEMBER THIS RECORD RUN?

fuel used was Texaco Sky Chief Marine Gasoline

Perhaps you remember the record: 280 miles around Long Island in 14 hours, 20 minutes . . . in the open Atlantic Ocean, Long Island Sound and through New York's crowded Tidal Harbor.

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With Texaco Outboard Motor Oil they had an oil tailor-made for outboards . . . because it prevents harmful deposits, keeps motors cool and smooth-running.

Give *your* motor the benefit of this great record-making combination . . . Texaco Sky Chief Marine gasoline, *and* Texaco Outboard Motor Oil. You'll get instant starts and steady, stall-free performance . . . the things that make boating fun. Next time out, visit your Texaco Waterfront Dealer, the best friend your boat has ever had.

THIS IS THE BOAT. It's a 17-foot Thompson Sea Lancer powered by a 35 h.p. Evinrude Lark . . . and Texaco Sky Chief Marine gasoline.

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